

FIG. 1

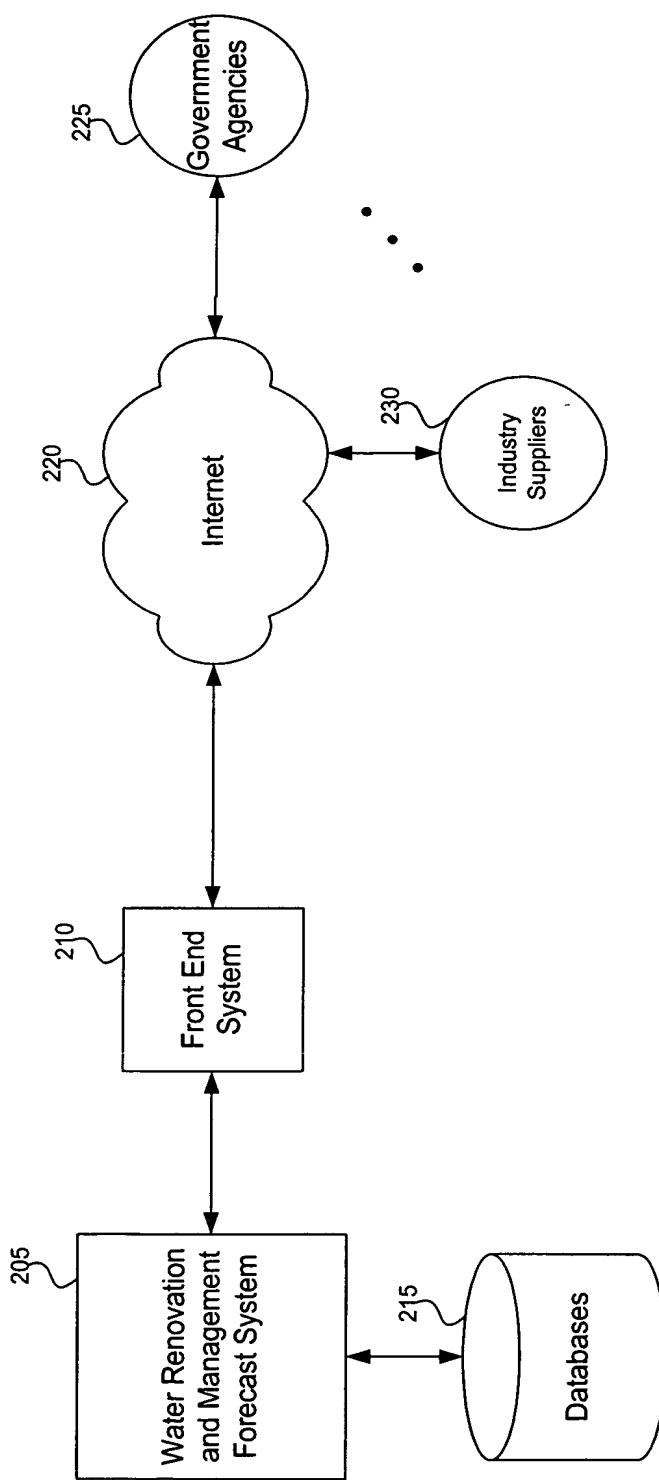


FIG. 2

Water Renovation and Management Forecast System 205

Replacement Sheet
Sheet 3 of 41
Appl. No. 09/547,791; Filed: Apr 12, 2000
Dkt No. 1481.0170000/PEG/TAD; Group Unit: 3623
Inventors: Beck et al.
Tel. No.: 202-371-2600
For: System, Method, and Computer Program Product for
Weather and Terrestrial Vegetation-Based Water
Renovation and Management Forecasting

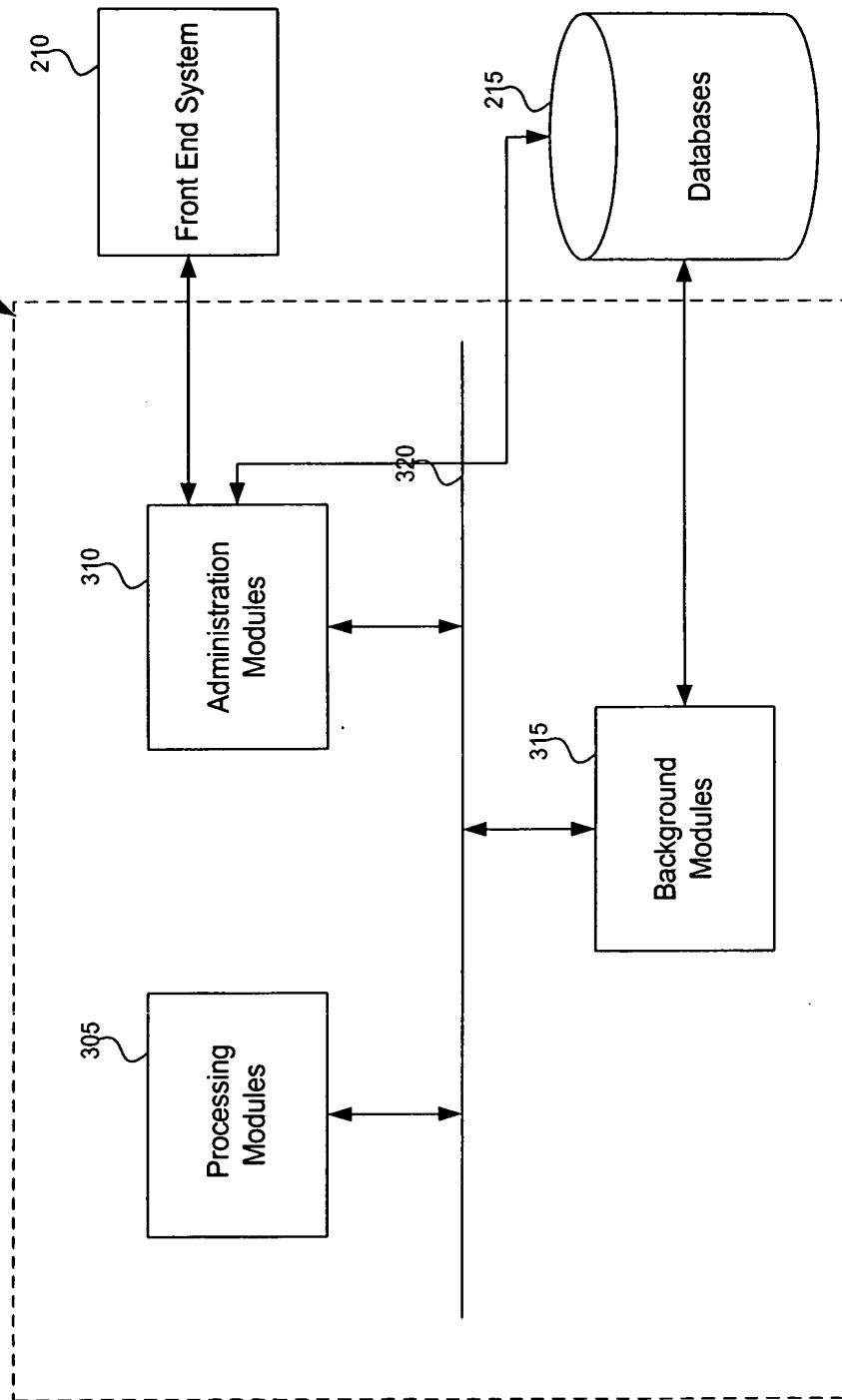


FIG. 3

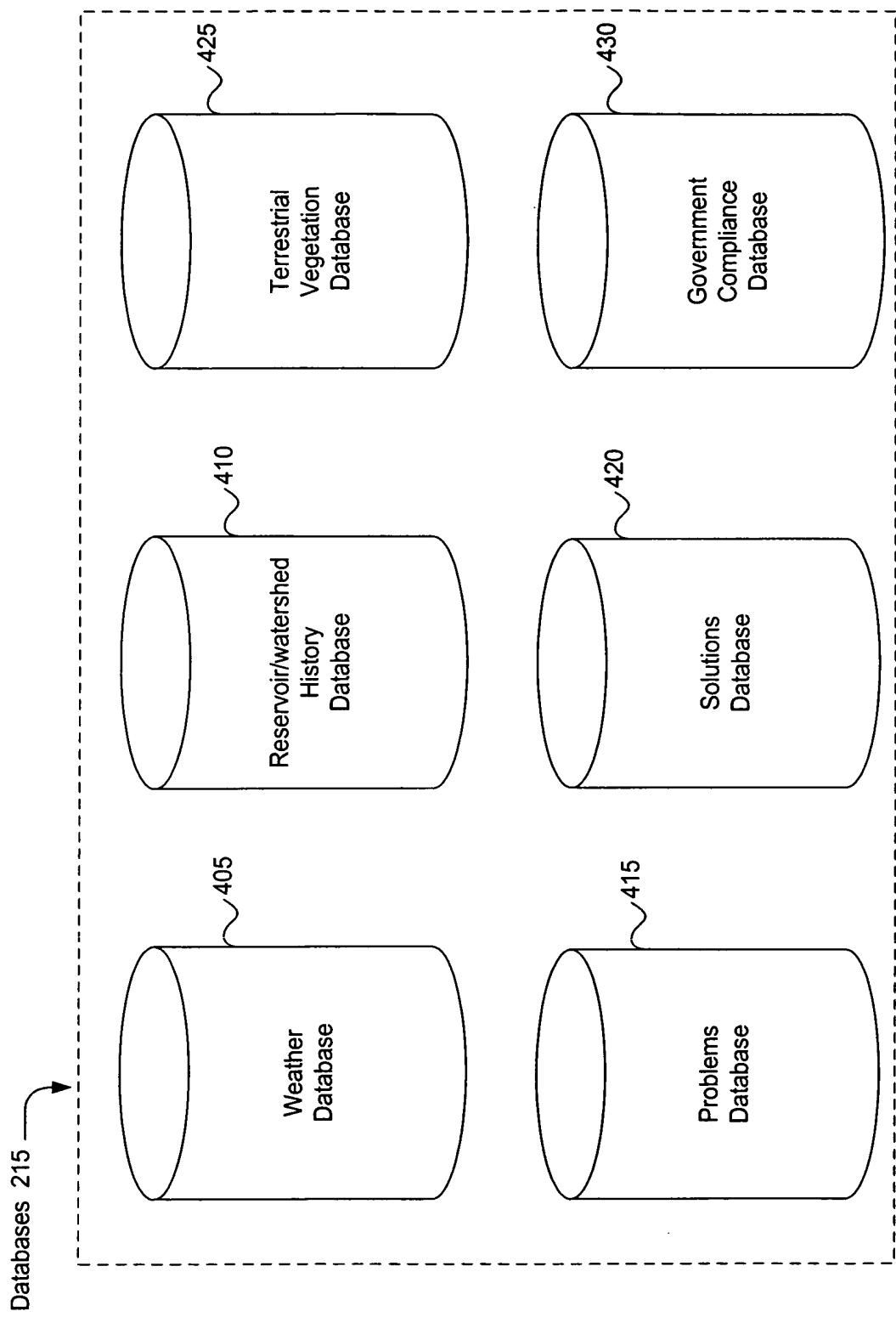


FIG. 4

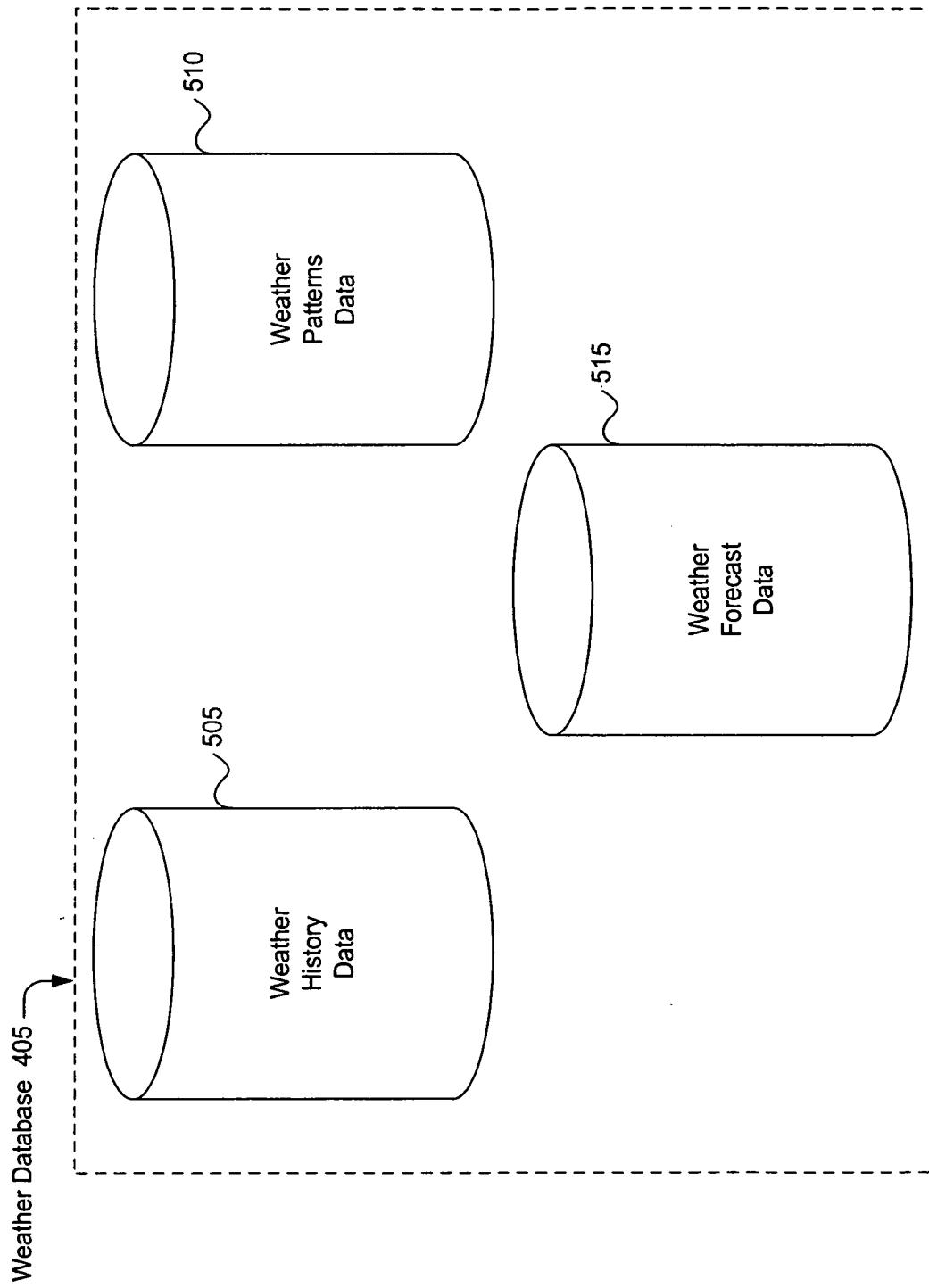


FIG. 5

Year	MA	Data Type	Period1	Period2	Period3	Period4	Period5	Period6
:	:	:	:	:	:	:	:	:
1997	MA100	temp_sea	46	47	50	51	49	47
1998	MA100	temp_sea	46	47	49	51	50	48
1997	MA100	prec_sea	1.01	1.03	1.08	1.1	1.12	1.1
1998	MA100	prec_sea	1.01	1.03	1.07	1.1	1.12	1.1
1997	MA100	wind_speed_sea	17	15	5	7	10	14
1998	MA100	wind_speed_sea	16	15	4	7	10	13
1997	MA100	solar_radiation.sea	3.4	4.1	4.2	5.5	4.3	3.8
1998	MA100	solar_radiation.sea	3.4	4.0	4.2	5.4	4.0	3.7
1997	MA100	cloud_cover.sea	75	75	25	25	25	75
1998	MA100	cloud_cover.sea	75	75	25	25	25	75
1997	MA100	cooling_rate.sea	0.2	0.3	0.2	0.2	0.2	0.1
1998	MA100	cooling_rate.sea	0.3	0.3	0.2	0.2	0.2	0.2
1997	MA100	growing_degree_days.sea	24	25	25	21	19	16
1998	MA100	growing_degree_days.sea	24	26	25	21	19	16
:	:	:	:	:	:	:	:	:

FIG. 6A

Year	MA	Data Type	Period1	Period2	Period3	Period4	Period5	Period6
1997	MA100	temp	49	43	45	47	50	42
1998	MA100	temp	53	51	56	50	58	54
1997	MA100	prec	1.5	0.4	0.9	1.3	1.7	0.3
1998	MA100	prec	1.1	0.01	2.68	1.78	0.48	0.01
1997	MA100	wind_speed	15	14	5	7	16	20
1998	MA100	wind_speed	12	15	10	8	18	21
1997	MA100	solar_radiation	3.0	4.1	4.0	5.2	4.3	4.0
1998	MA100	solar_radiation.sea	3.4	4.0	4.5	5.4	4.0	3.7
1997	MA100	cloud_cover	100	75	25	25	25	0
1998	MA100	cloud_cover	75	75	25	25	25	25
1997	MA100	cooling_rate	0.3	0.3	0.2	0.2	0.2	0.1
1998	MA100	cooling_rate	0.3	0.3	0.2	0.2	0.2	0.2
1997	MA100	growing_degree_days	26	27	25	25	19	16
1998	MA100	growing_degree_days	23	26	25	20	19	15
:	:	:	:	:	:	:	:	:

Weather History Data 505
 605 }
 610 }
 615 }
 620 }
 623 }

FIG. 6B

Year	MA	Data Type	Period1	Period2	Period3	Period4	Period5	Period6
1997	MA100	temp.cat	1	-1	-1	-1	1	-1
1998	MA100	temp.cat	1	1	1	-1	1	1
1997	MA100	prec.cat	1	-1	-1	1	1	-1
1998	MA100	prec.cat	1	-1	1	1	-1	-1
1997	MA100	wind_speed.cat	-1	-1	0	0	1	1
1998	MA100	wind_speed.cat	-1	0	1	1	1	1
1997	MA100	solar_radiation.cat	-1	0	-1	-1	0	1
1998	MA100	solar_radiation.cat	0	0	-1	0	0	0
1997	MA100	cloud_cover.cat	1	0	0	0	0	-1
1998	MA100	cloud_cover.cat	0	0	0	0	0	-1
1997	MA100	cooling_rate.cat	1	0	0	0	0	0
1998	MA100	cooling_rate.cat	0	0	0	0	0	0
1997	MA100	growing_degree_days.cat	1	1	0	1	0	0
1998	MA100	growing_degree_days.cat	-1	0	0	-1	0	-1
:	:	:	:	:	:	:	:	:

Weather History Data 505

620

615

610

605

625
627
630
633

FIG. 6C

Weather Patterns Data 510

- TEMPERATURE/PRECIPITATION
 - SEASONAL/SEASONAL
 - SEASONAL/ABOVE SEASONAL
 - SEASONAL/BELLOW SEASONAL
 - ABOVE SEASONAL/SEASONAL
 - ABOVE SEASONAL/ABOVE SEASONAL
 - ABOVE SEASONAL/BELLOW SEASONAL
 - BELOW SEASONAL/SEASONAL
 - BELOW SEASONAL/ABOVE SEASONAL
 - BELOW SEASONAL/BELLOW SEASONAL
 - TEMPERATURE/SOLAR RADIATION
 - SEASONAL/SEASONAL
 - SEASONAL/ABOVE SEASONAL
 - SEASONAL/BELLOW SEASONAL
 - ABOVE SEASONAL/SEASONAL
 - ABOVE SEASONAL/ABOVE SEASONAL
 - ABOVE SEASONAL/BELLOW SEASONAL
 - BELOW SEASONAL/SEASONAL
 - BELOW SEASONAL/ABOVE SEASONAL
 - BELOW SEASONAL/BELLOW SEASONAL
 - CLOUD COVER/SOLAR RADIATION
 - SEASONAL/SEASONAL
 - SEASONAL/ABOVE SEASONAL
 - SEASONAL/BELLOW SEASONAL
 - ABOVE SEASONAL/SEASONAL
 - ABOVE SEASONAL/ABOVE SEASONAL
 - ABOVE SEASONAL/BELLOW SEASONAL
 - BELOW SEASONAL/SEASONAL
 - BELOW SEASONAL/ABOVE SEASONAL
 - BELOW SEASONAL/BELLOW SEASONAL
 - COOLING RATE/SOLAR RADIATION
 - SEASONAL/SEASONAL
 - SEASONAL/ABOVE SEASONAL
 - SEASONAL/BELLOW SEASONAL
 - ABOVE SEASONAL/SEASONAL
 - ABOVE SEASONAL/ABOVE SEASONAL
 - ABOVE SEASONAL/BELLOW SEASONAL
 - BELOW SEASONAL/SEASONAL
 - BELOW SEASONAL/ABOVE SEASONAL
 - BELOW SEASONAL/BELLOW SEASONAL
 - PRECIPITATION/WIND SPEED
 - SEASONAL/SEASONAL
 - SEASONAL/ABOVE SEASONAL
 - SEASONAL/BELLOW SEASONAL
 - ABOVE SEASONAL/SEASONAL
 - ABOVE SEASONAL/ABOVE SEASONAL
 - ABOVE SEASONAL/BELLOW SEASONAL
 - BELOW SEASONAL/SEASONAL
 - BELOW SEASONAL/ABOVE SEASONAL
 - BELOW SEASONAL/BELLOW SEASONAL
- ⋮

FIG. 7A

Weather Patterns Data 510

- SUSTAINED WEATHER
 - TEMPERATURE SUSTAINED 2 PERIODS
 - TEMPERATURE SUSTAINED 3 PERIODS
 - PRECIPITATION SUSTAINED 2 PERIODS
 - PRECIPITATION SUSTAINED 3 PERIODS
 - WIND SPEED SUSTAINED 2 PERIODS
 - WIND SPEED SUSTAINED 3 PERIODS
 - SOLAR RADIATION SUSTAINED 2 PERIODS
 - SOLAR RADIATION SUSTAINED 3 PERIODS
 - CLOUD COVER SUSTAINED 2 PERIODS
 - CLOUD COVER SUSTAINED 3 PERIODS
 - COOLING RATE SUSTAINED 2 PERIODS
 - COOLING RATE SUSTAINED 3 PERIODS
 - GROWING DEGREE DAYS SUSTAINED 2 PERIODS
 - GROWING DEGREE DAYS SUSTAINED 3 PERIODS
- TEMPERATURE/PRECIPITATION LAG 1 PERIOD
 - SEASONAL/SEASONAL
 - SEASONAL/ABOVE SEASONAL
 - SEASONAL/Below SEASONAL
 - ABOVE SEASONAL/SEASONAL
 - ABOVE SEASONAL/ABOVE SEASONAL
 - ABOVE SEASONAL/Below SEASONAL
 - Below SEASONAL/SEASONAL
 - Below SEASONAL/ABOVE SEASONAL
 - Below SEASONAL/Below SEASONAL
- TEMPERATURE/SOLAR RADIATION LAG 1 PERIOD
 - SEASONAL/SEASONAL
 - SEASONAL/ABOVE SEASONAL
 - SEASONAL/Below SEASONAL
 - ABOVE SEASONAL/SEASONAL
 - ABOVE SEASONAL/ABOVE SEASONAL
 - ABOVE SEASONAL/Below SEASONAL
 - Below SEASONAL/SEASONAL
 - Below SEASONAL/ABOVE SEASONAL
 - Below SEASONAL/Below SEASONAL
- CLOUD COVER/SOLAR RADIATION LAG 1 PERIOD
 - SEASONAL/SEASONAL
 - SEASONAL/ABOVE SEASONAL
 - SEASONAL/Below SEASONAL
 - ABOVE SEASONAL/SEASONAL
 - ABOVE SEASONAL/ABOVE SEASONAL
 - ABOVE SEASONAL/Below SEASONAL
 - Below SEASONAL/SEASONAL
 - Below SEASONAL/ABOVE SEASONAL
 - Below SEASONAL/Below SEASONAL

FIG. 7B

Year	MA	Data Type	Period1	Period2	Period3	Period4	Period5	Period6
N+1	MA100	temp_sea	47	49	52	54	55	
N+1	MA100	prec_sea	1.00	1.03	1.06	1.05	1.10	1.1
N+1	MA100	wind_speed_sea	18	14	5	7	11	15
N+1	MA100	solar_radiation_sea	3.4	4.1	4.2	5.4	4.2	3.7
N+1	MA100	cloud_cover_sea	75	75	25	0	25	75
N+1	MA100	cooling_rate_sea	?	?	?	?	?	?
N+1	MA100	growing_degree_days_sea	24	27	27	25	20	17
:	:	:	:	:	:	:	:	:
N+1	MA100	temp	48	49	50	53	55	57
N+1	MA100	prec	1.1	1.05	1.05	1.00	1.15	1.2
N+1	MA100	wind_speed	16	16	7	5	16	20
N+1	MA100	solar_radiation	3.5	4.5	4.5	5.5	5.0	4.3
N+1	MA100	cloud_cover	75	25	75	25	0	25
N+1	MA100	cooling_rate	0.2	0.3	0.2	0.2	0.2	0.2
N+1	MA100	growing_degree_days	24	28	26	22	20	16
:	:	:	:	:	:	:	:	:

FIG. 8A

Year	MA	Data Type
N+1	MA100	temp.cat
N+1	MA100	prec.cat
N+1	MA100	wind_speed.cat
N+1	MA100	solar_radiation.cat
N+1	MA100	cloud_cover.cat
N+1	MA100	cooling_rate.cat
N+1	MA100	growing_degree_days.cat
:	:	:
605	610	615
810	815	815
Weather Forecast Data 515		
620		
Period6		
Period5		
Period4		
Period3		
Period2		
Period1		

FIG. 8B

Year	Reservoir MA	Description of Watershed	Recorded Problems	Attempted Solutions	Uses (%)																
					945	950	955	960	965	970	975	980	985	990	995	996	997	998	999		
Terrain (%)																					
Aquatic Systems (%)																					
Streams/ Rivers																					
Wetlands																					
Ponds																					
Other																					
Industry																					
Residential																					
Forest																					
Cropland																					
Grassland																					
1997	R1	MA 58 100	95	90	95	95	975	980	985	987	989	990	991	992	993	994	995	996	997	998	999
1998	R1	MA 40 100	48	9	2	0	1	30	45	25	0	OP6									
1997	R2	MA 25 101	0	45	5	23	4	20	0	80	0	OP4									
1998	R2	MA 25 101	0	45	5	23	4	20	0	80	0	OP4									
1997	R3	MA 20 135	0	30	5	45	0	50	0	50	0	OP6									
1998	R3	MA 20 135	0	30	3	48	0	40	10	50	0	OP6									
991																					
993																					
Number of People Served																					
Size in Acres of Water Supply versus Total Size																					
Ownership Type																					
Period6																					
Period5																					
Period4																					
Period3																					
Period2																					
Period1																					
Period6																					
Period5																					
Period4																					
Period3																					
Period2																					
Period1																					
Other																					
Flood Control																					
Drinking Water																					
Irrigation																					
Recreation																					
Power Plant Cooling																					
Other																					
994																					
995																					
996																					
997																					
998																					
999																					

Reservoir/
Watershed
History
Database 410

FIG. 9

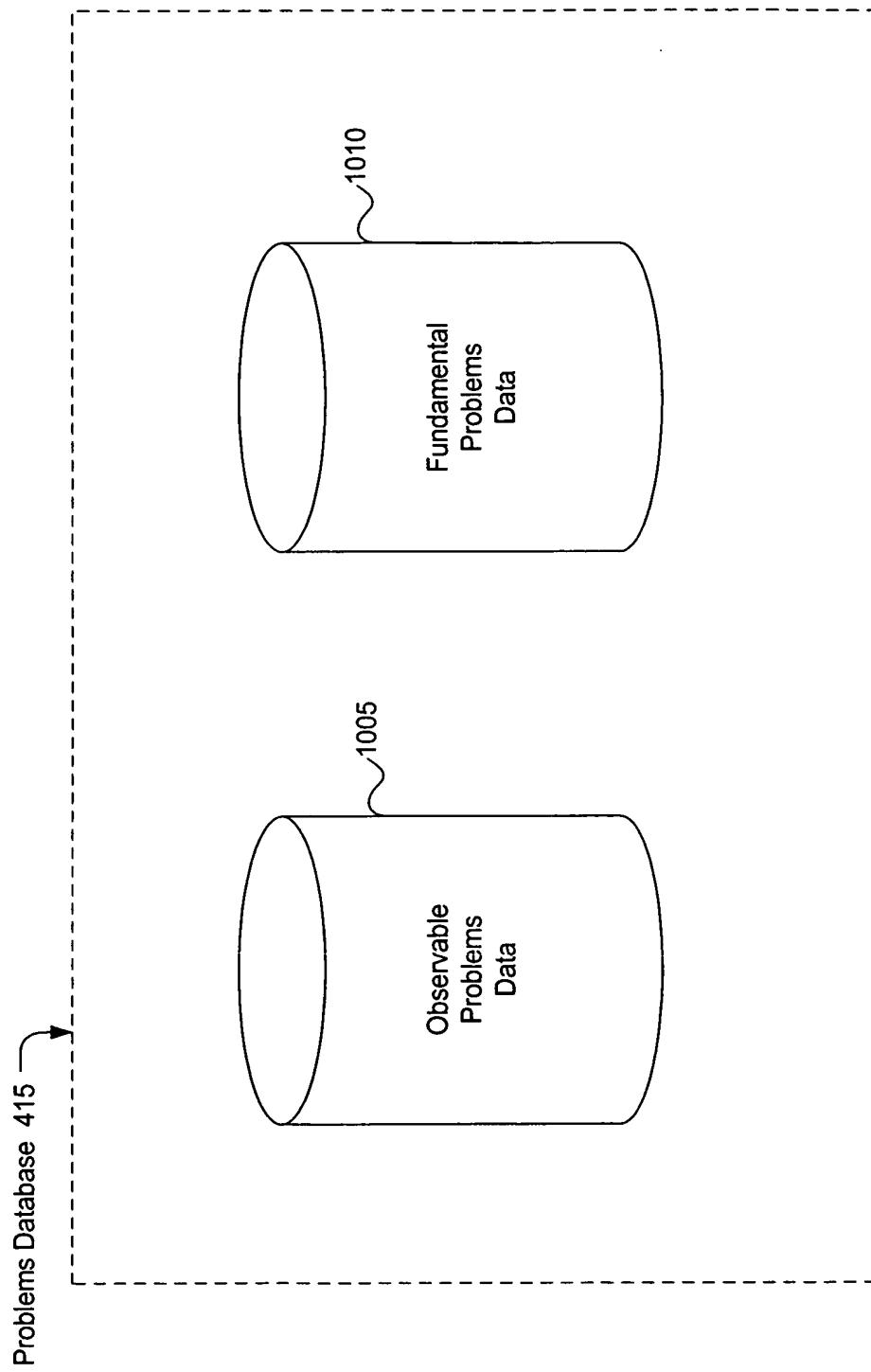


FIG. 10

Observable Problems Data 1005

Observable Problem	Description	Related Fundamental/Observable Problems
OP1	Objectionable Taste and Odor Conditions	OP3, OP6, FP2, FP3, FP4
OP2	Declining Wildlife (e.g., fish)	OP5, OP6, OP8, FP3, FP4
OP3	Shallow Water	FP3
OP4	Decreased Water Clarity	FP3, FP4
OP5	Decreased Water Flow	FP3, FP4
OP6	Excessive Plant Growth	FP1, FP4
:	:	:

FIG. 11

Fundamental Problems Data 1010 →

Fundamental Problem	Description	Related Weather Causes	Related Terrestrial Vegetation Causes	Possible Solutions (✓)					
				S1	S2	S3	S4	S5	S6
FP1 1225	Elevated Plant Nutrient Levels	Excessive watershed runoff due to high precipitation and/or high wind speed; high temperature; high solar radiation and/or reduced cloud coverage increasing water temperature, decreasing water circulation, and increasing plant growth	Early season greenness in agricultural areas; Late season greenness in agricultural areas	✓	✓				
FP2	Elevated Chemical Levels (Geosmin)	High solar radiation, high temperatures, low cooling rate, and/or reduced cloud coverage decreasing water circulation and increasing plant growth	Early season greenness in agricultural areas; Late season greenness in agricultural areas	✓	✓	✓	✓	✓	✓
FP3	Siltation	Excessive watershed runoff due to high precipitation and/or high wind speed	Early season greenness in agricultural areas; Late season greenness in agricultural areas	✓	✓			✓	✓
FP4	Thermal Stratification	Warm temperatures in the spring and early summer; High solar radiation, high temperatures, low cooling rate, and/or reduced cloud coverage decreasing water circulation		✓	✓				
:	:	:		:	:	:	:	:	:

FIG. 12

Type of Solution	Solution	Description	Term	Economic Impact	Political Impact	Environmental Impact
Physical	S1	Adjust Water Level	short	low	high	medium
	S2	Cut Weeds	short	medium	low	low
	S3	Dredge	long	high	low	low
	S4	Aeration (Destratification)	short	medium	low	low
	S5	Alter Adjacent Land Use	long	high	high	high
	S6	Disinfect (Water Treatment)	long	high	low	low
	S7	Filter (Water Treatment)	long	high	low	low
	S8	Apply different types of fertilizer to crops	short	low	high	medium
	S9	Apply fertilizer at time sensitive times relating to terrestrial greenness	short	low	high	low
	S10	Introduce Herbicides	short	medium	high	high
	S11	Introduce Fish	long	medium	low	low
Chemical	:	:	:	:	:	:
Biological	:	:	:	:	:	:

FIG. 13

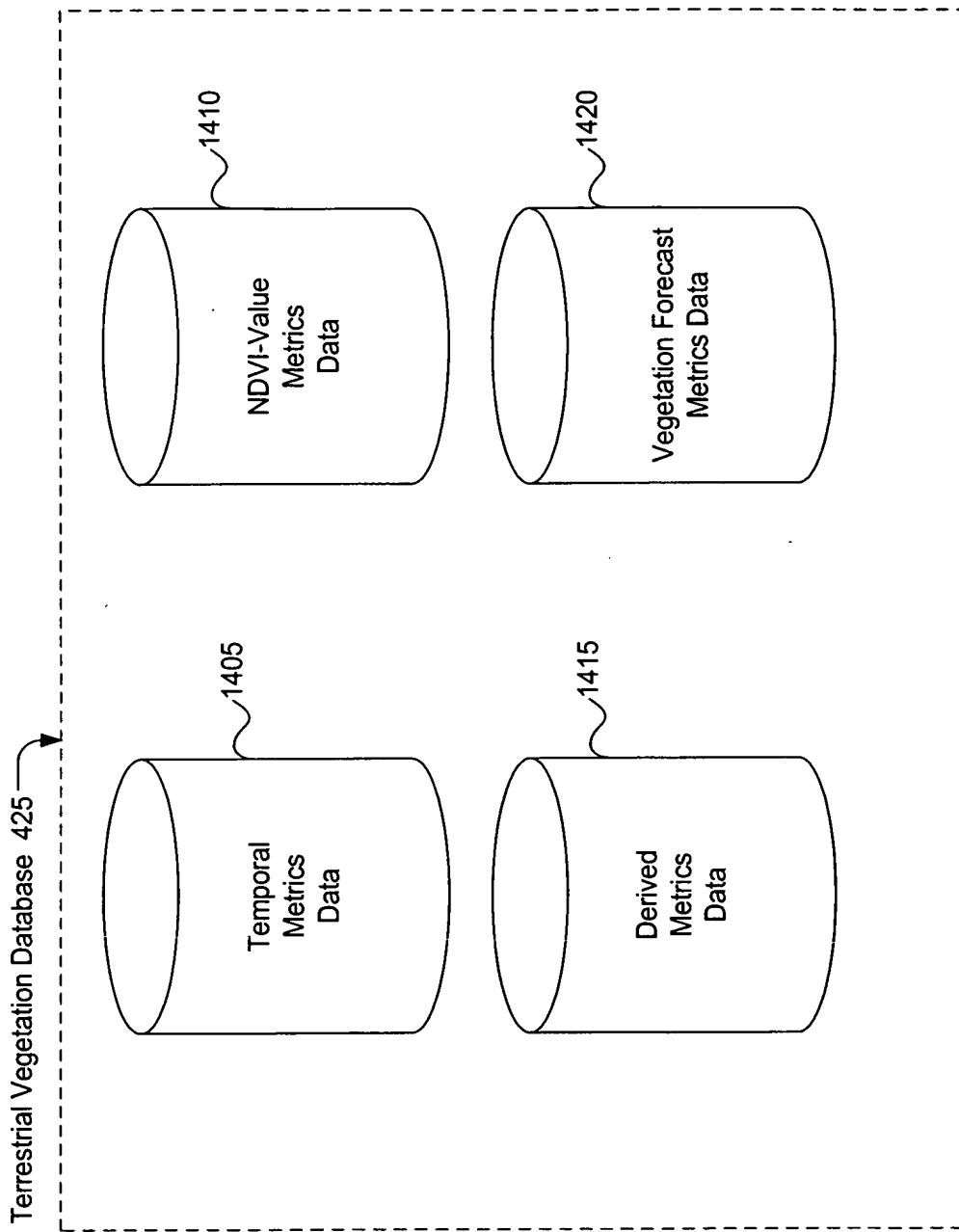


FIG. 14

Year	MA	Temporal Metrics					
		1510	1515	1520	1525	Duration of Greenness 620	Time of Maximum Greenness 620
		Time of Onset of Greenness 620	Time of End of Greenness 620				
Period6	Period5	Period4	Period3	Period2	Period1	Period6	Period5
1997	MA100	80	81	80	88	86	81
1998	MA100	75	77	80	85	83	239|244|266|250|249|164|167|186|165|166|186|190|179|178|185
1997	MA101	92	93	101|101|100	95	251|250|251|249|245|250|159|157|150|148|145|151|89|183|182|180|189|189	
1998	MA101	101|101|115|115|103	97	245|250|250|246|245|250|144|149|135|131|142|153|186|180|189|191|190			
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮

Temporal Metrics Data 1405 →

FIG. 15

Year	MA	Value of Onset of Greenness 620	Value of End of Greenness 620	NDVI-Value Metrics						Range of NDVI 620	1625
				1605	610	1610	1615	1620	1625		
1998	MA100	115|117|120|119|125|110|120|121|120|118|120|117|121|120|169|171|168|169|170|170|49|48|47|51|47|50									
1997	MA100	120|125|122|119|126|115|118|120|119|117|121|120|169|171|168|169|170|170|49|48|47|51|47|50									
1998	MA100	115|117|120|119|125|110|120|121|120|118|120|119|119|115|165|166|170|171|169|170|48|47|50|48|47									
1997	MA101	132|133|150|117|130|125|130|118|120|119|119|115|165|166|170|171|169|50|51|48|54|53|50									
1998	MA101	145|151|130|120|125|125|135|119|125|120|120|116|169|170|171|169|170|48|51|53|53|48|50									
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮

FIG. 16

FIG. 17

Vegetation Forecast Metrics Data 1420 →

Year	MA	1510			1515			Temporal Metrics			1610			1615			NDVI-Value Metrics			1620			1625			1710			1715			Derived Metrics			1720			1725		
		Time of Onset of Greenness	620	Duration of Greenness	620	Time of End of Greenness	620	Maximum Greenness	620	Value of Onset of Greenness	620	Value of End of Greenness	620	Range of NDVI	620	Accumulated NDVI	620	Rate of Green-up	620	Rate of Senescence	620	Mean Daily NDVI	620	Mean Daily NDVI	620	Mean Daily NDVI	620	Mean Daily NDVI	620	Mean Daily NDVI	620	Mean Daily NDVI	620	Mean Daily NDVI	620	Mean Daily NDVI	620			
...							
1805	N+1	MA100	75	80	251	250	170	170	185	191	120	122	120	120	171	170	50	49	1610	1550	21	20	1.8	-1.8	150	145	...	...	...	...	...	...	...
1810	N+1	MA101	92	90	250	250	171	172	190	190	120	121	119	120	170	170	49	46	1600	1600	20	20	-1.7	-1.8	150	150	...	...	...	...	...	...	...
...							

FIG. 18

Government Compliance Database 430

Type	State/Locality	MA(s) Applicable	Permit Required for Solution (✓)								
			S1	S2	S3	S4	S5	S6	S7	S8	S9
Federal	-	MA100 - MA1780							✓		...
State	Alabama	MA201 - MA215	✓		✓		✓		✓		...
	Alaska	MA100 - MA109	✓	✓	✓	✓	✓	✓	✓	✓	...
	Arkansas	MA390 - MA415	✓	✓	✓	✓	✓	✓	✓	✓	...
	:	:
Local	Allegheny County, PA	MA129	✓	✓	✓	✓	✓	✓	✓	✓	...
	Avency County, MD	MA909									...
	Buck County, PA	MA128	✓	✓	✓	✓	✓	✓	✓	✓	...
	:	:

FIG. 19

Background Modules 315 →

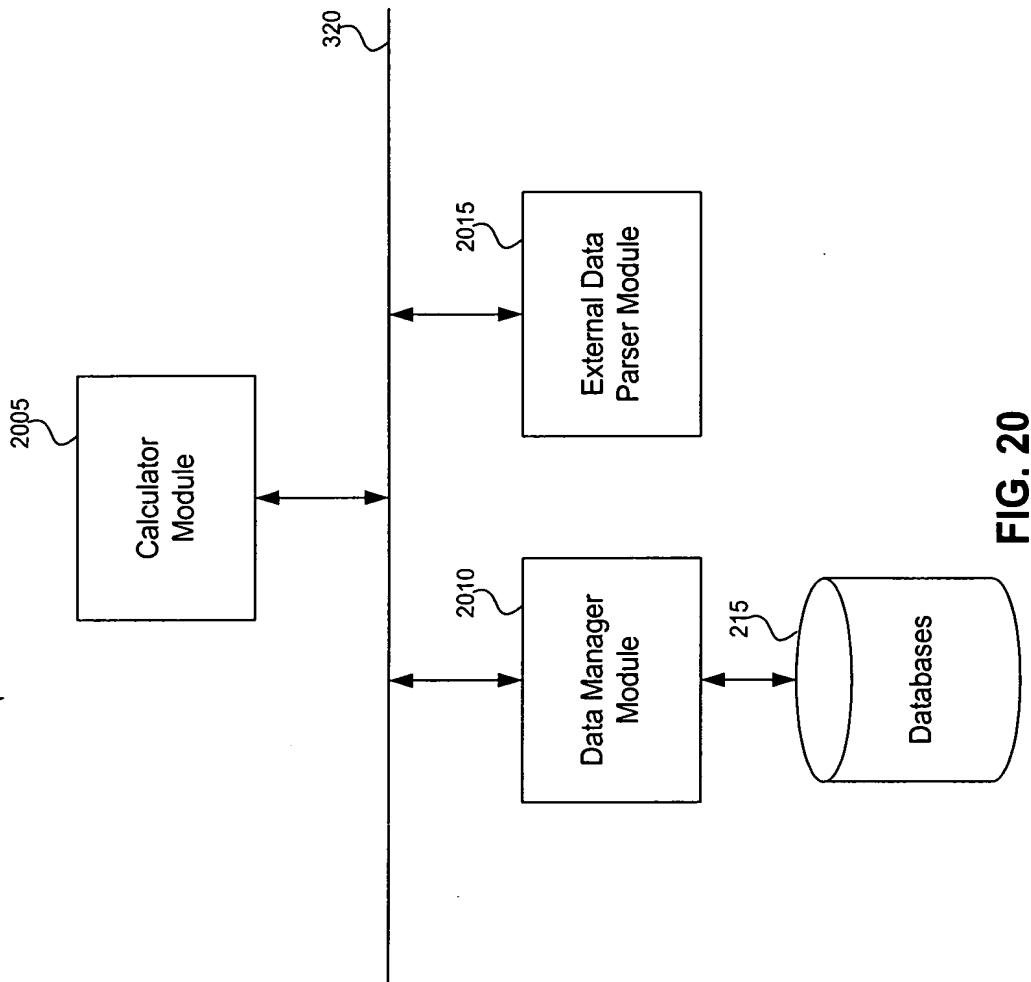


FIG. 20

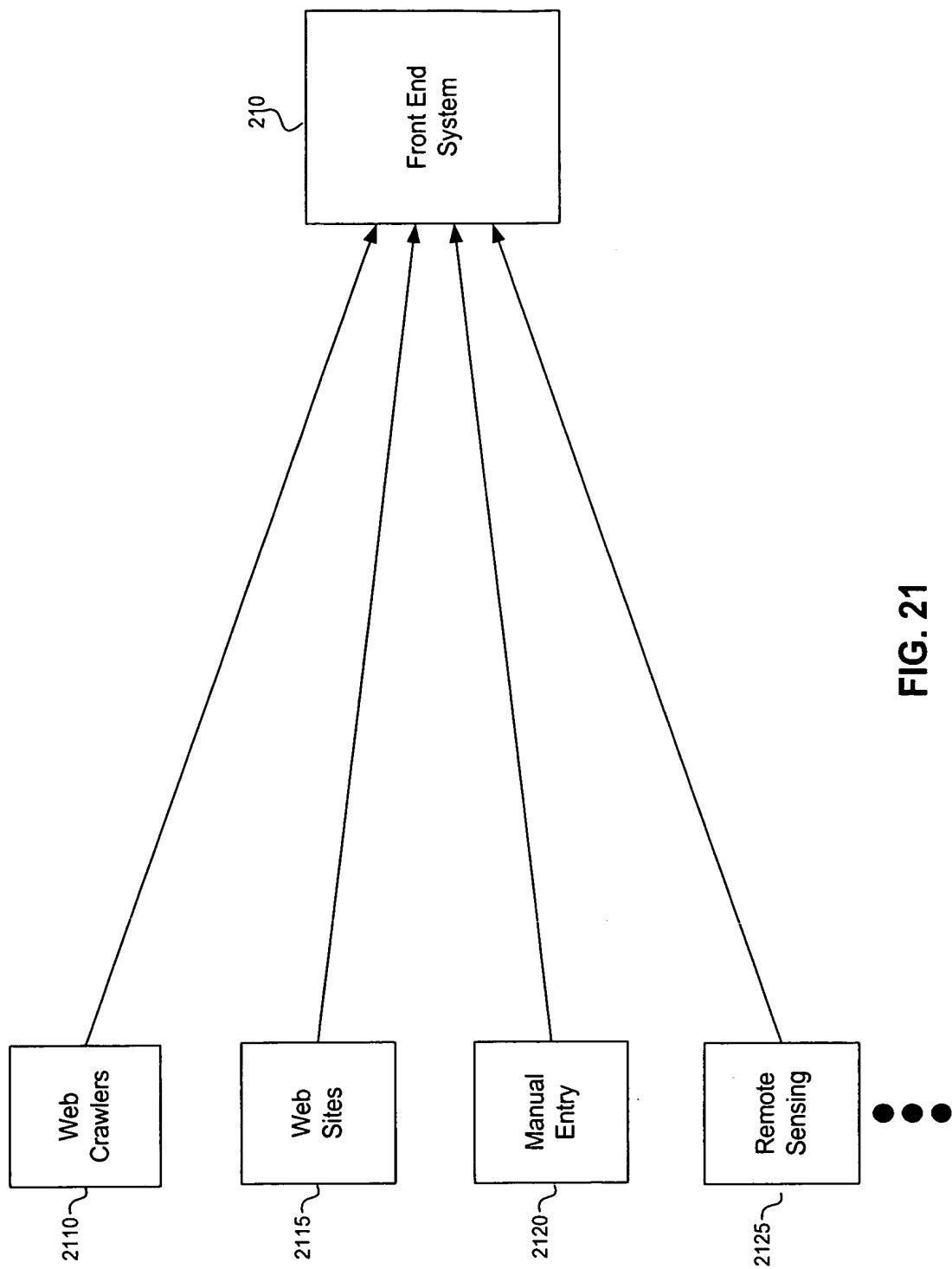


FIG. 21

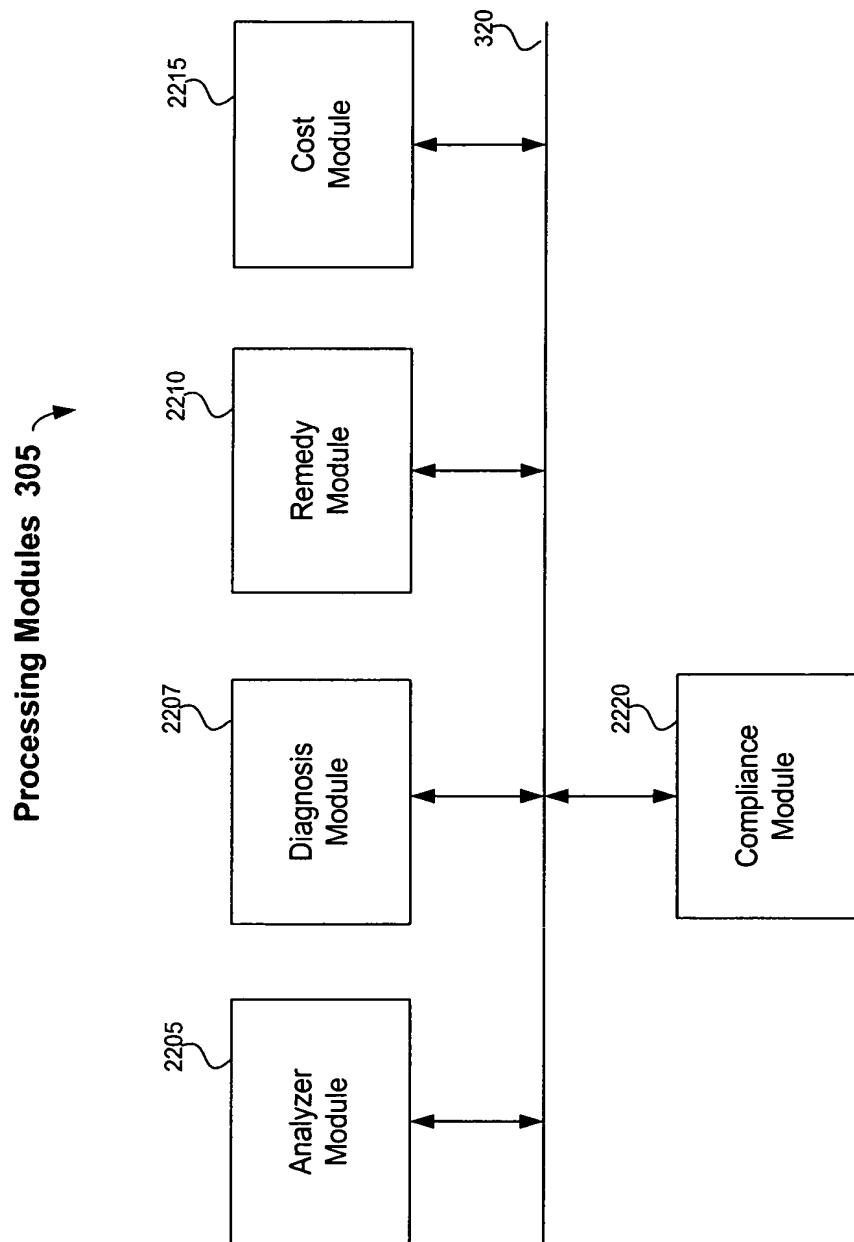


FIG. 22

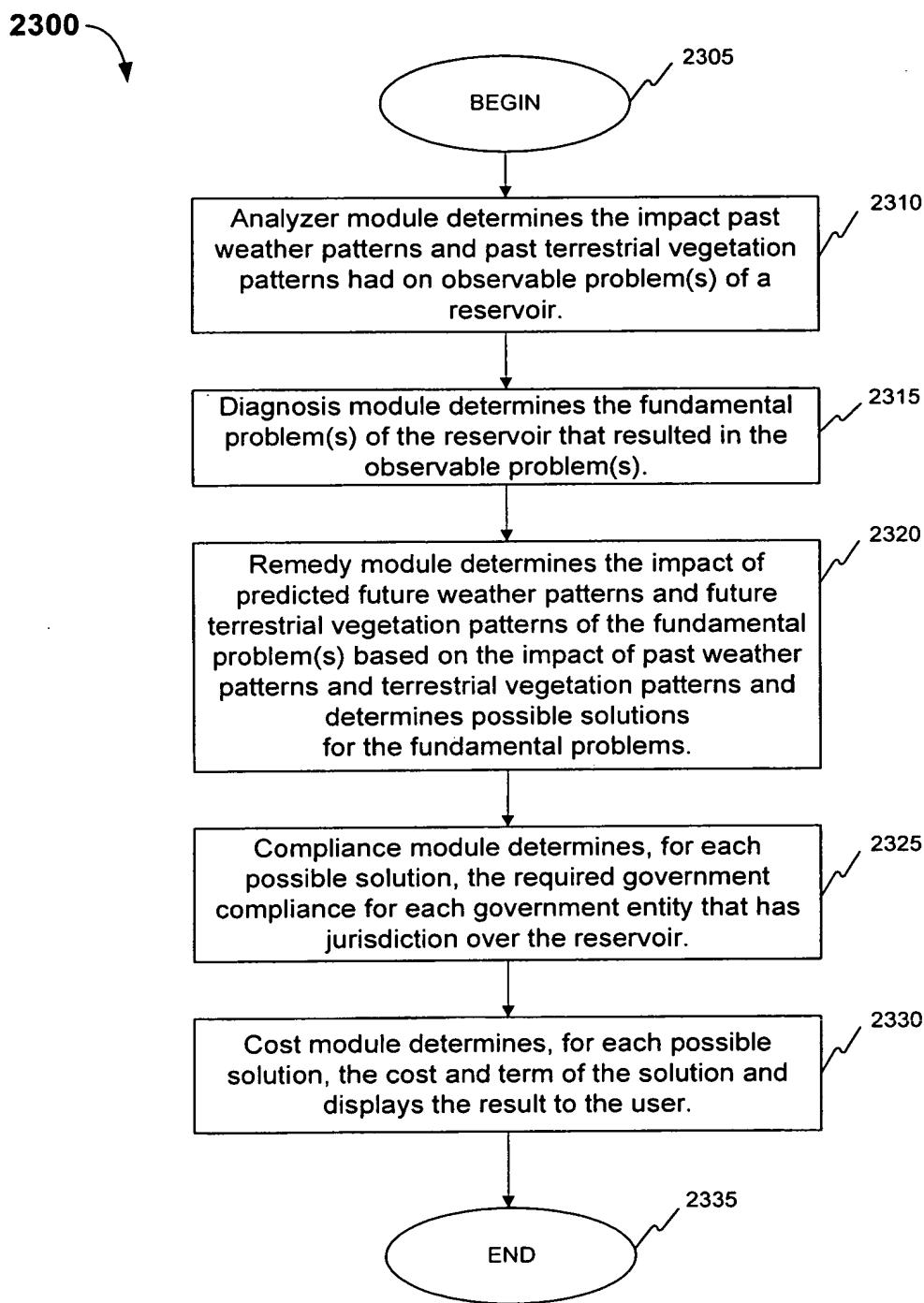


FIG. 23

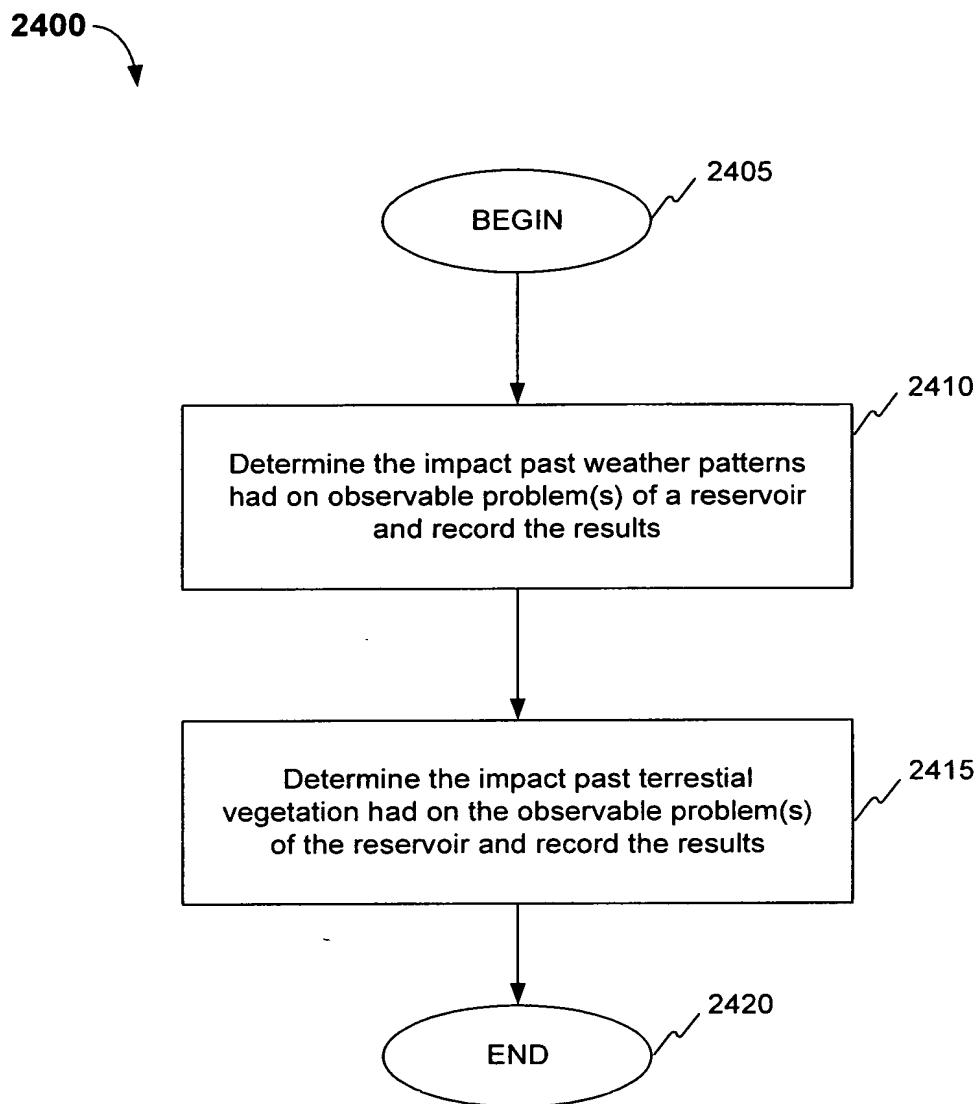


FIG. 24

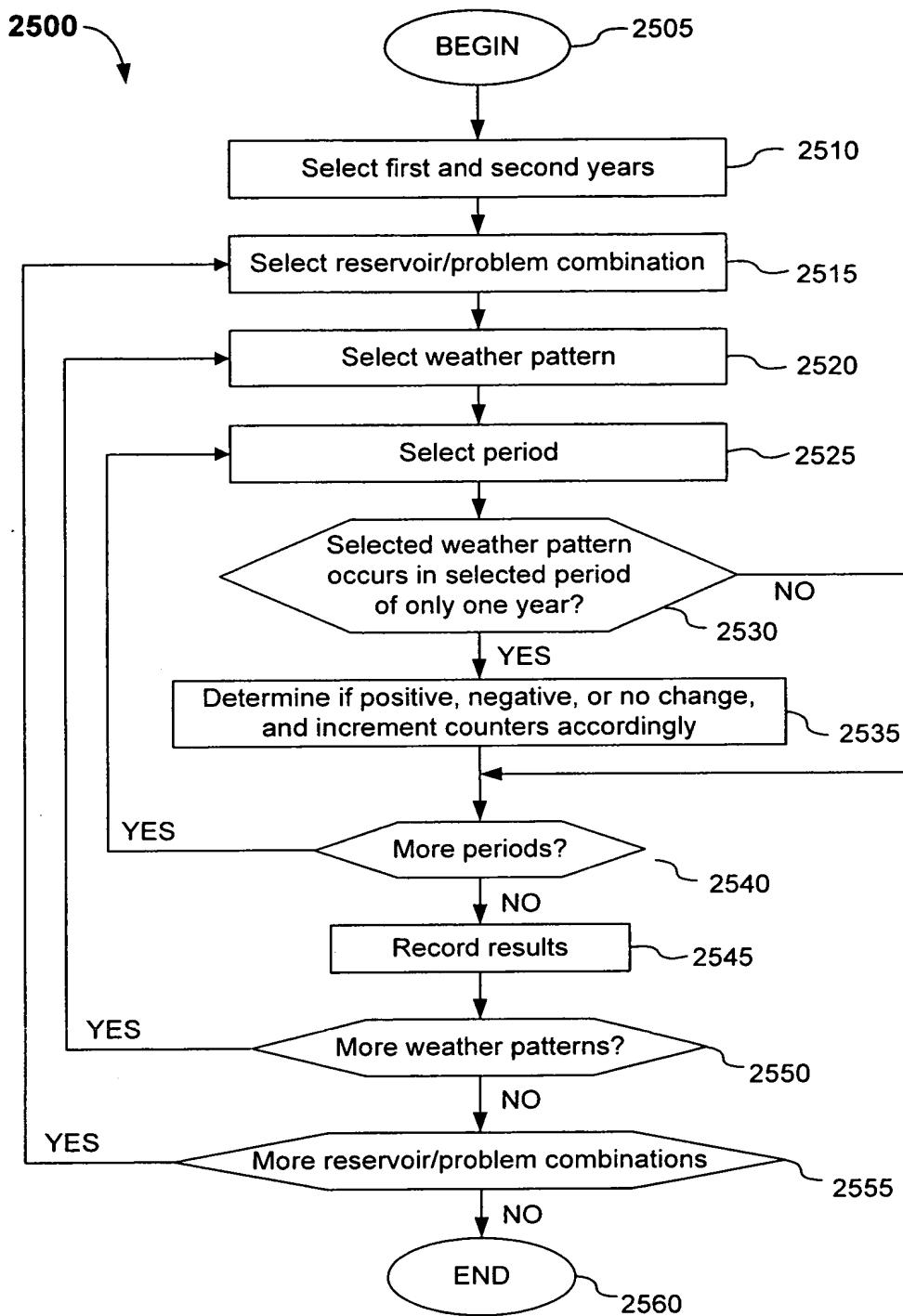


FIG. 25

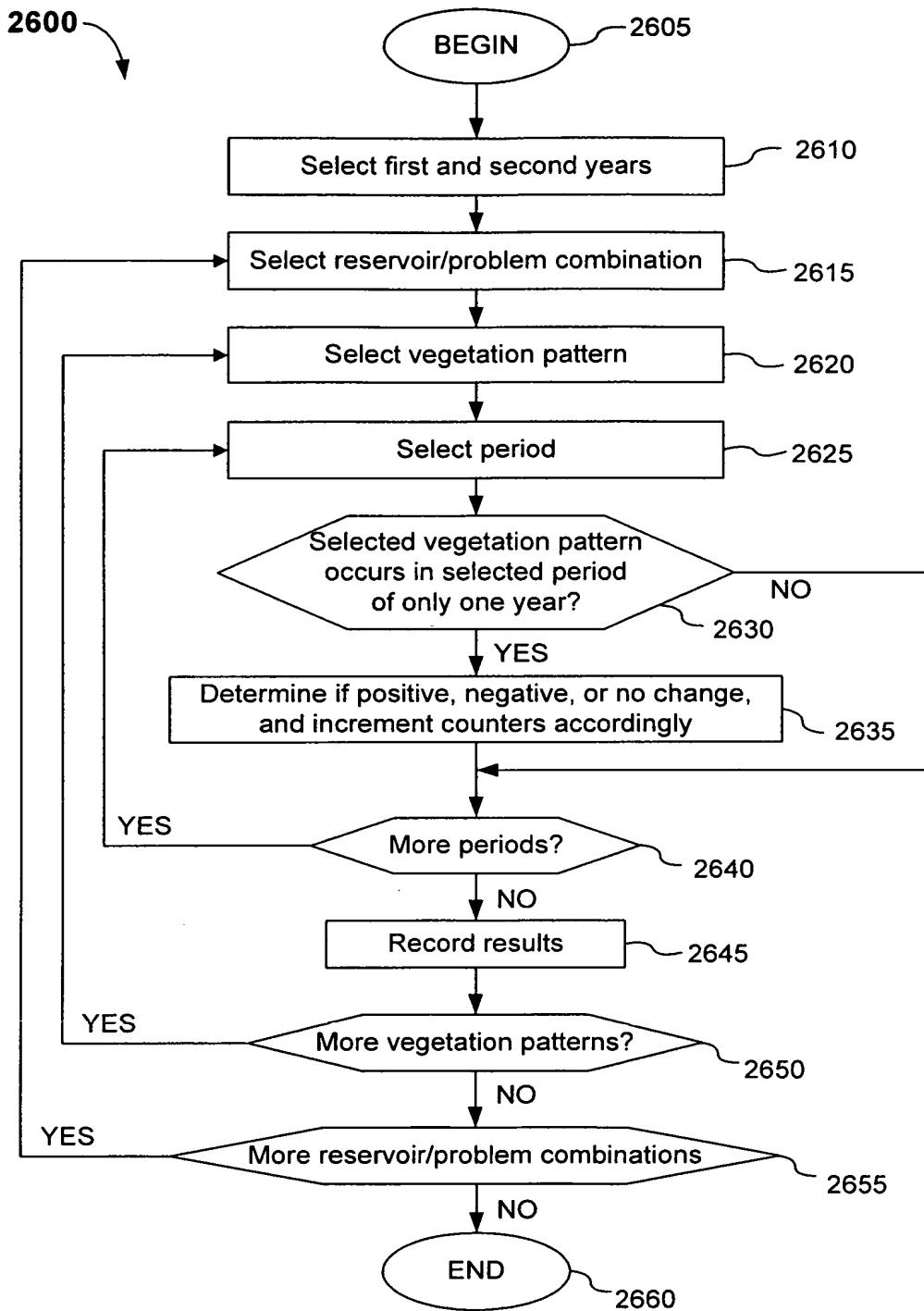


FIG. 26

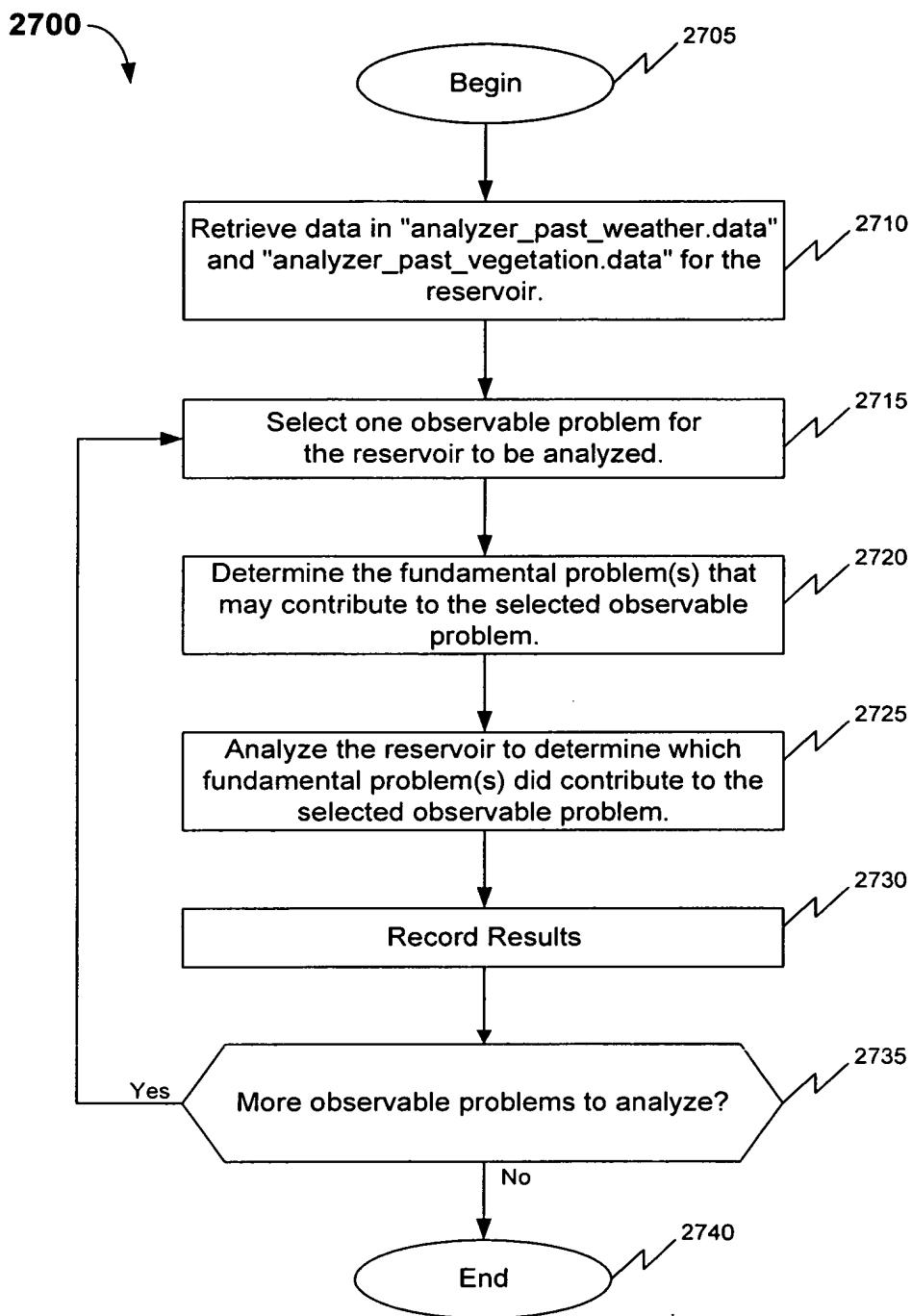


FIG. 27

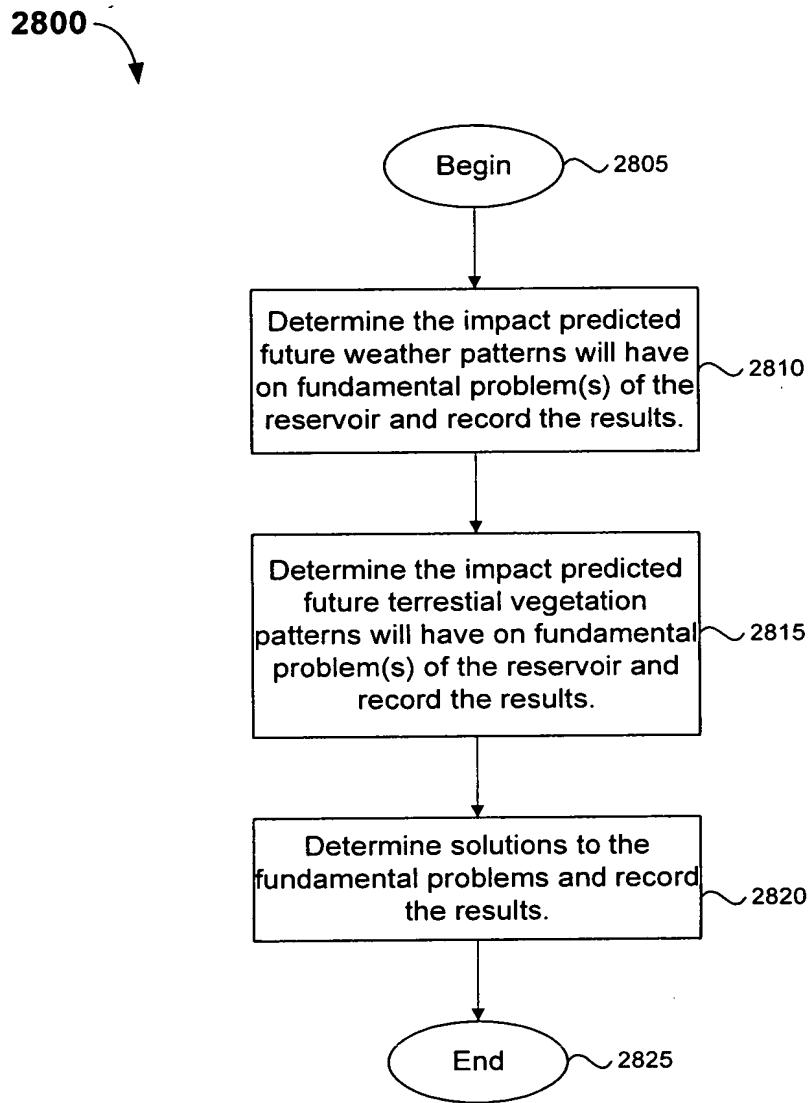


FIG. 28

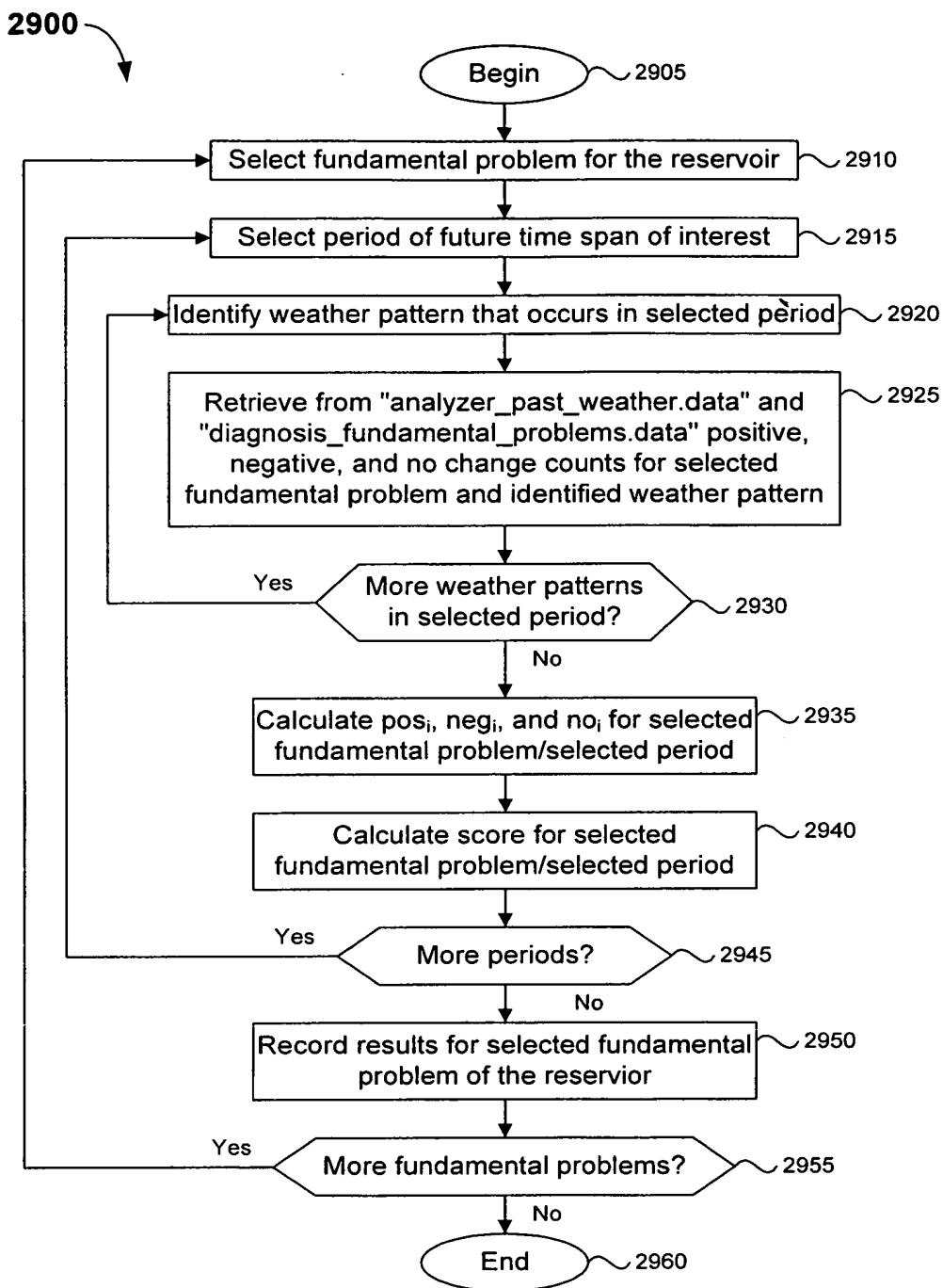


FIG. 29

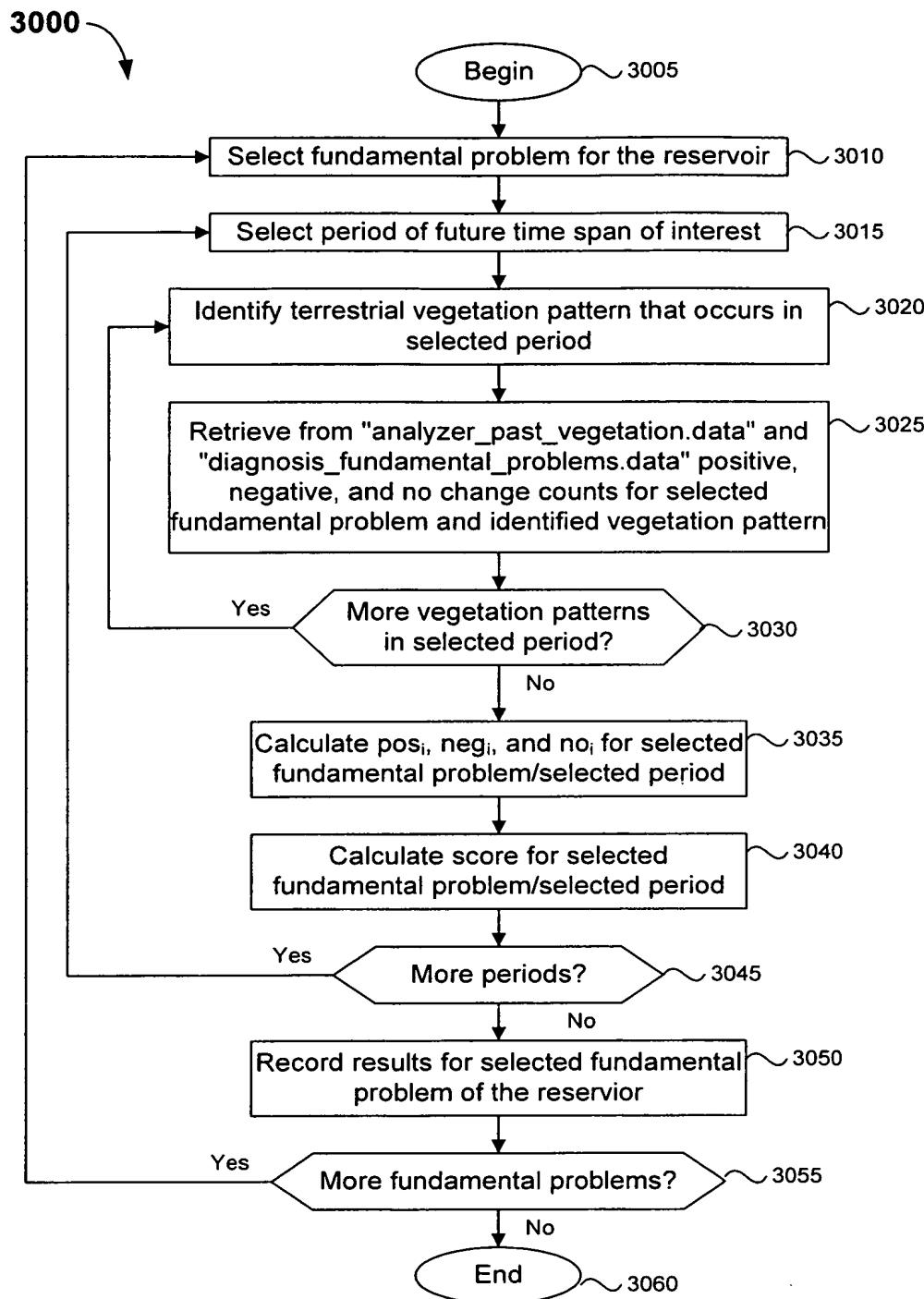


FIG. 30

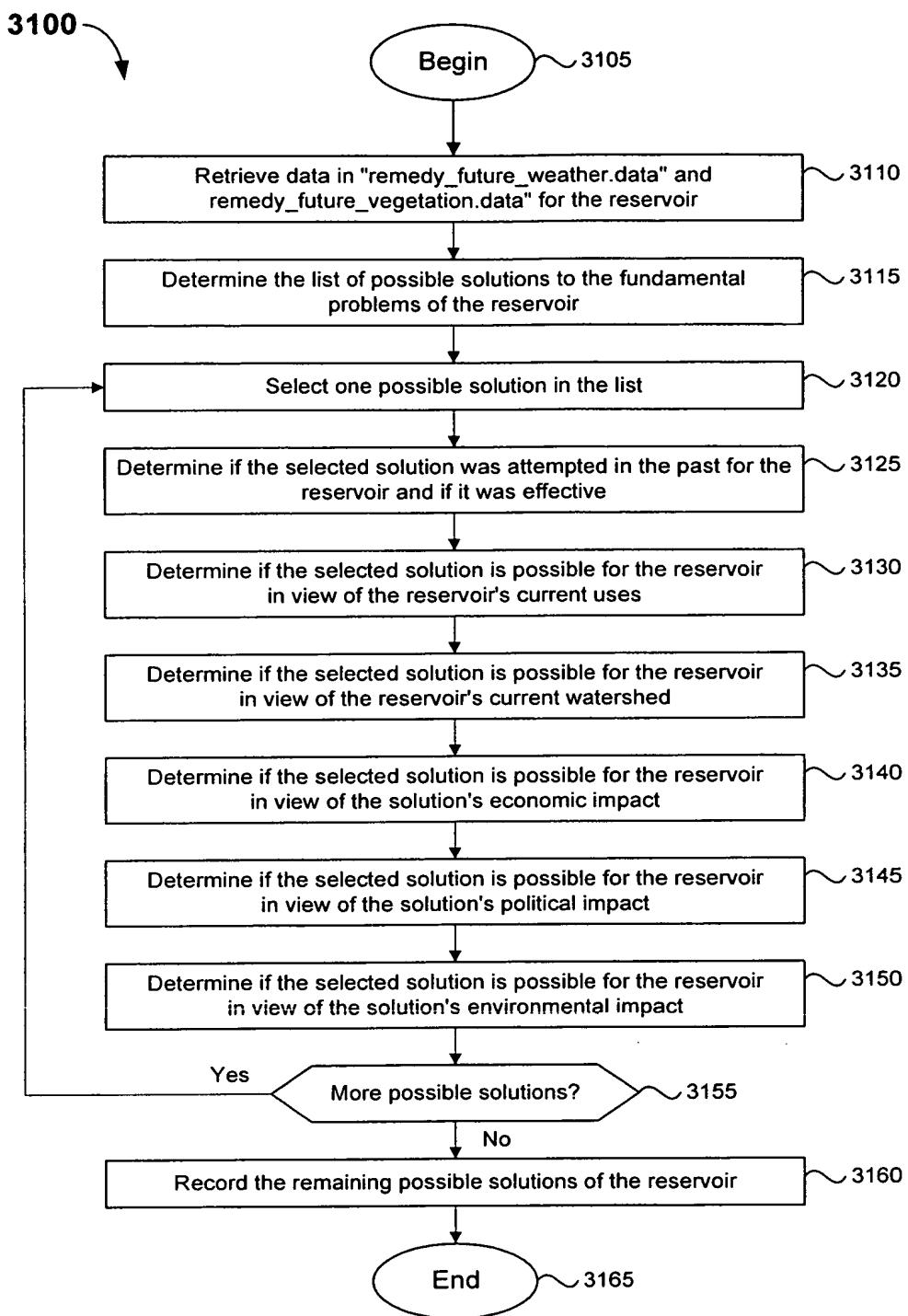


FIG. 31

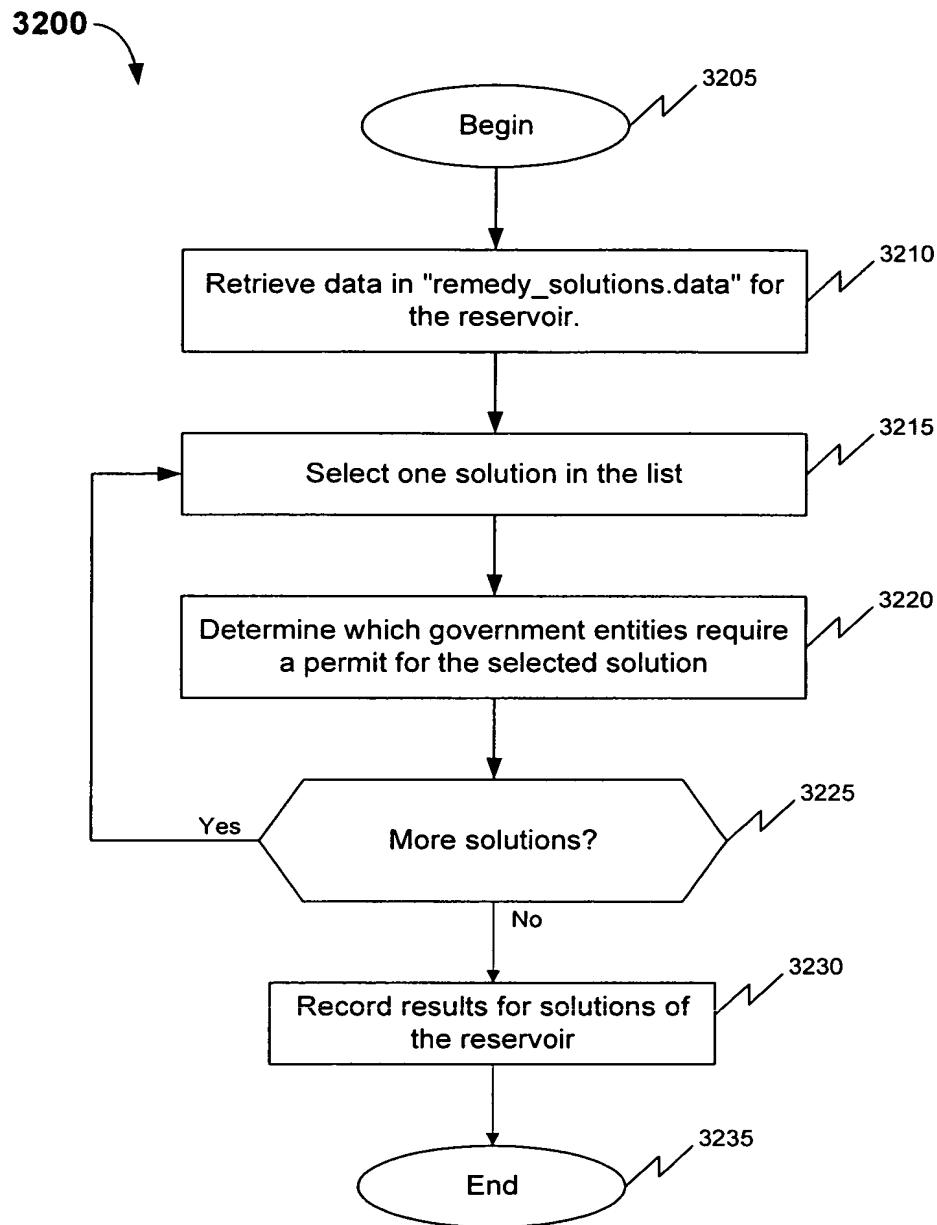


FIG. 32

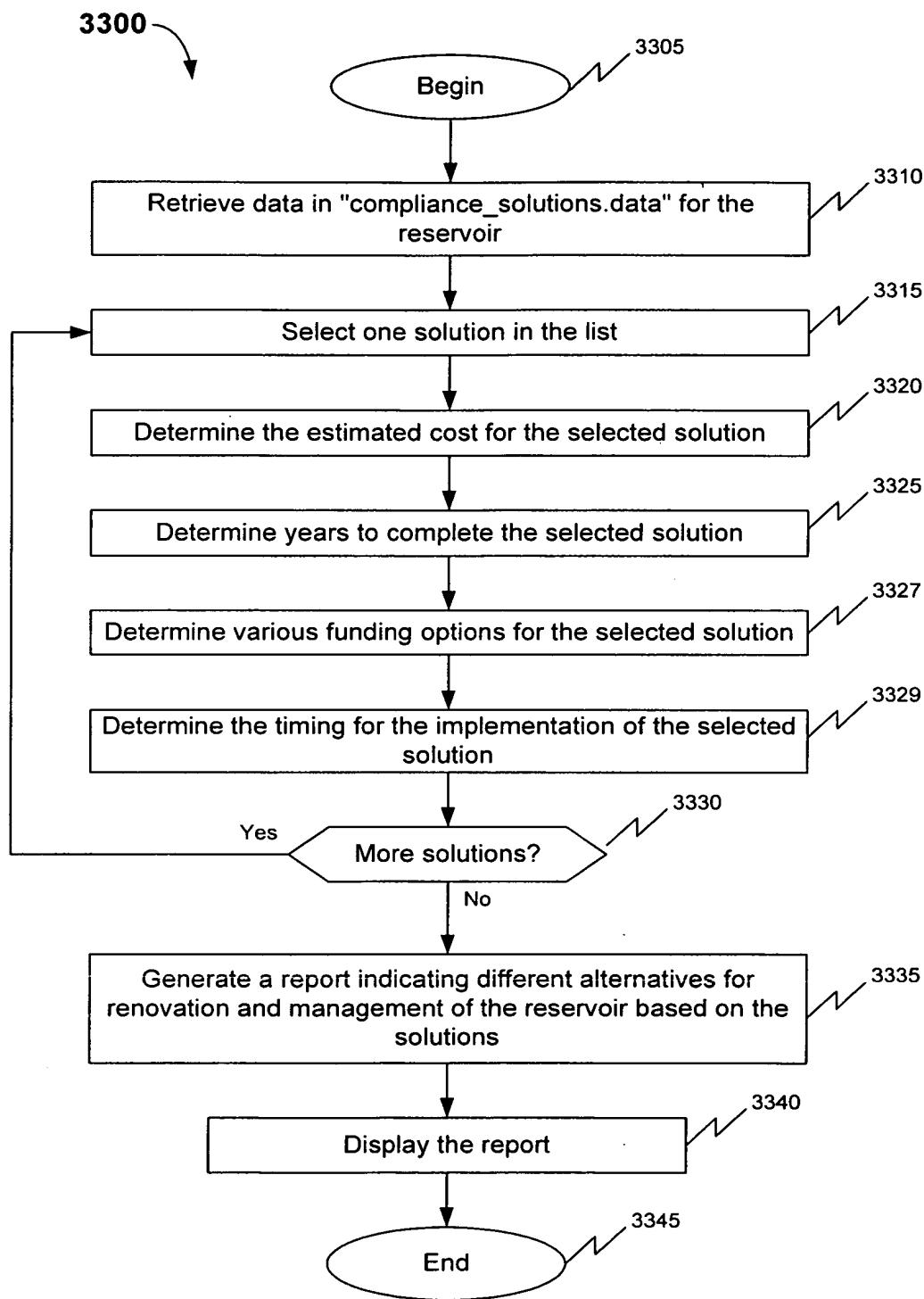


FIG. 33

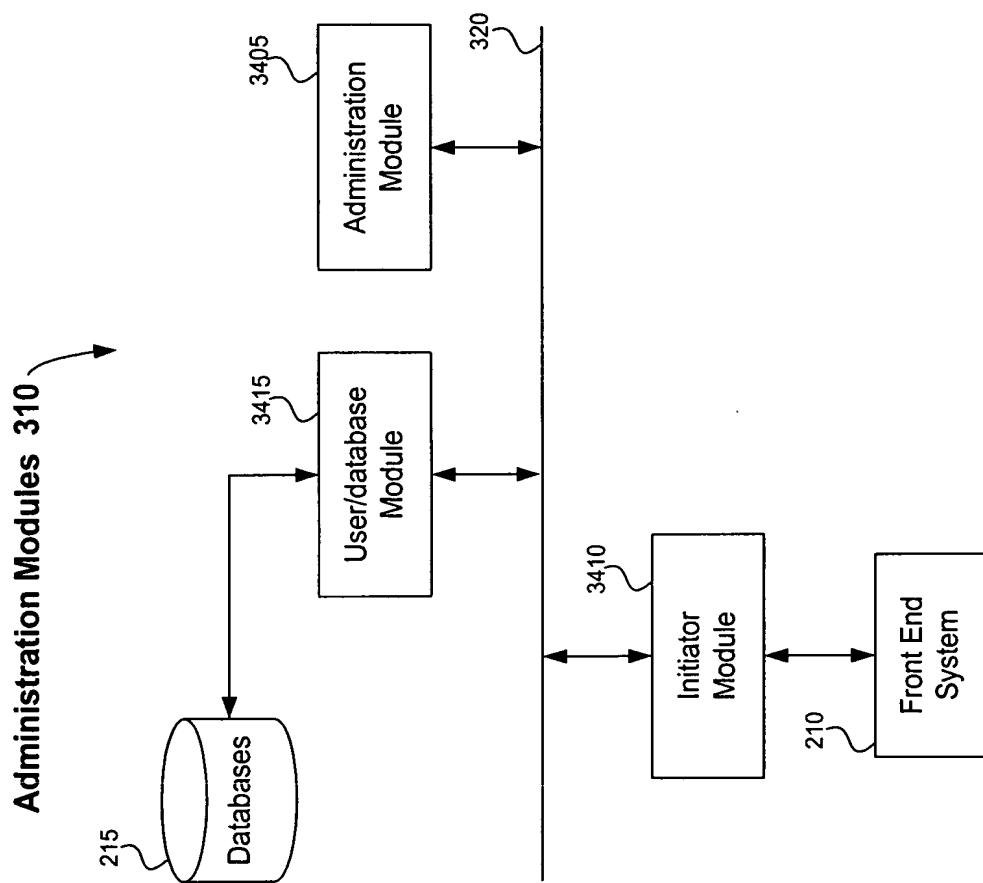


FIG. 34

Computer System 3500

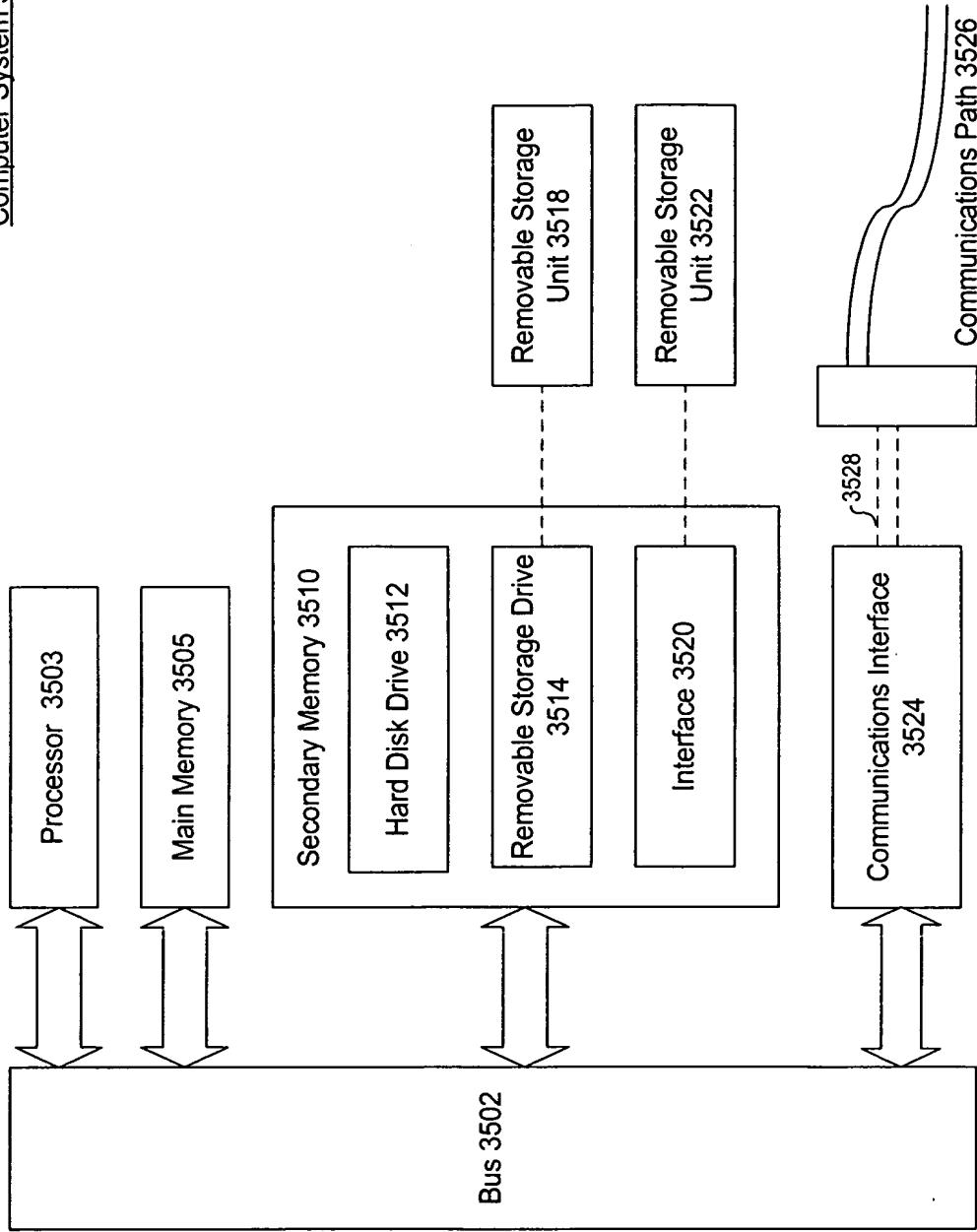
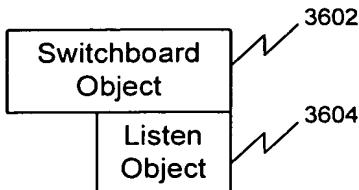


FIG. 35

CLIENT



SERVER

